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THE PATHOLOGICAL ANATOMY OF POTATO SCAB

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WITH TEN FIGURES IN THE TEXT

Although potato scab is widespread in this country and Europe, occurring every year in abundance, the only phase of the disease that has been at all extensively studied is that of methods of prevention. The lesions produced by the disease are so characteristic and involve such unique tissue changes that the pathology of scab has a general botanical interest.

As has been shown by Kny, Massart (9), and Olufsen (10), the periderm of the potato is regenerated with the greatest ease from any of the cells of the starch parenchyma. It is not even necessary, according to Massart, to remove the cork layer nor to kill the cells in order to stimulate the cells underneath the cork to divide to form a new cork layer and he was able by simply applying pressure to induce the formation of a new cork layer under the old uninjured one.

The disease known as "scab" is now believed to be due to organisms in the soil, which, acting on the cork cambium, stimulate it to hyperplasie and hypertrophy.

Bolley (2) isolated from the tissue under the lesions a true bacterium which, on inoculation, would produce the disease. These bacteria were rods, 1μ by 7μ in fresh cultures, but in tubes that had been kept for some time, they had rounded up into cocci, 7μ to 8μ in diameter. These cocci had approximately the same dimensions as the spherical bodies he was able to observe in the cork cambium and the underlying starch parenchyma cells.

Thaxter (11) isolated from scabby potatoes in Connecticut a filamentous organism capable of producing scab on inoculation. He classified this organism with the lower fungi (Oospora).

Bolley (3) working in North Dakota (his previous investigations had been conducted at Lafayette, Indiana) was not able to repeat his Indiana isolations and inoculations of a bacterium but found an organism closely resembling that of Thaxter's, always associated with the scab.

Cunningham (4) has proposed taking the Thaxter organism out of the true fungi and classifying it with the soil Streptothrices to which it seems to be more nearly related.

It is still in some measure a matter of question as to whether all forms of scab are due to the same cause and involve essentially the same pathological conditions, or whether under the general designation of scab we are really dealing with a group of diseases possibly caused by distinct organisms.

Humphrey (7) has endeavored to divide the American disease into superficial scab and deep scab, although he admits "that the causes determining the development of the deep form are wholly indefinable."

Frank and Krüger (6) claimed to be able to distinguish gross morphological differences in the scabs found on the German potatoes. These varieties of scab were named, (1) shallow scab (Flachschorf), (2) deep scab (Tiefschorf), (3) bulging scab (Buckelschorf), (4) bulging deep scab (Buckeltiefschorf). These distinctions, however, are probably between different stages in the advance of the same disease rather than between scabs produced by different organisms. According to my own observations, the German and American scab are the same disease and do not warrant any division into definite groups, as the intermediate stages between such classes are too numerous and represent all gradations.

No detailed account, with figures, of the origin and growth of the scab tissue seems to have been published, although Frank (5) and Bolley (2) give one or two semi-diagrammatic drawings of sections of old scabs. The pathological tissue changes are entirely different in the "wart" disease due to *Chrysophlyctis endobiotica* although at times there might be a superficial resemblance, in its external appearance, to that of the scab. The pathology of true scab is only concerned with the cork layer, the cork cambium, and an underlying thin layer of starch parenchyma.

My method in the following work was to fix young potatoes, or small pieces of potato containing scab, in Flemming's weaker solution, imbed, section, and stain. Practically all the results are from such sections. The potatoes used were of the Green Mountain variety. The earliest stages of scab recognizable as such, had a diameter of 0.5 mm. The staining was done either with safranin alone, safranin followed by haematoxylin, or safranin followed by gentian violet. The suberised walls of the cells stain red with any of these combinations, while the cellulose ones are either colorless or purple. In addition to the sections, glycerine mounts of potato skin containing young scabs were examined.

The development and structure of the corky layer enclosing the potato tuber is very simple. The cork is already 6 to 10 cell layers thick, with the cells arranged in rows, when the young tuber is only a small white terminal bud of the size of a pea. There seems after this initial growth to be very little increase in the number of cell layers although the growth of the surface area of the cells must be continued in order to provide for the

enlarging tuber. The suberisation of the walls is not very marked, as shown by the staining reaction, until the tuber itself begins to turn brown. Figure 1 is from a section of the cork of a tuber of the size of a hulled walnut. The epidermis at this time often cannot be distinguished from the underlying cork cells. The innermost cells of the cork constitute the most active dividing layer, if their thickness is an indication. Under the cork layer is the starch parenchyma, the outer cells of which, as a rule, do not contain very much starch.

The first lenticels are to be seen as white spots on the tuber when the latter reaches a diameter of a centimeter. They increase in number during the early stages in the growth of the tuber, the new ones being formed between the old ones.

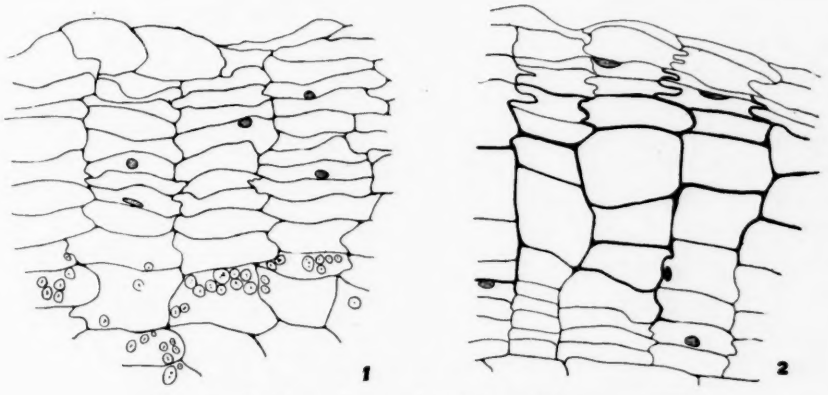
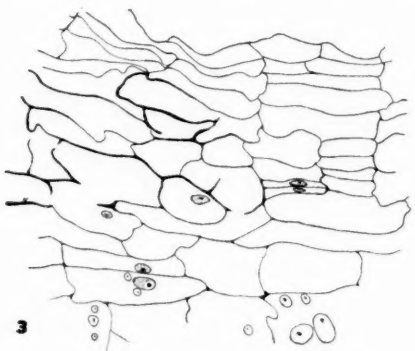


FIG. 1. Section of normal potato periderm. × 150.
FIG. 2. Section of a young scab. × 150.

It is very difficult to distinguish much detail, even under the low power of the microscope, in the unstained glycerine mounts of the corky layer containing the youngest recognizable scabs. The enlarged, thick-walled cells of a layer lying beneath the cork can, however, be made out. I can find no evidence to support the statement of Frank and Krüger (6) and Humphrey (7, p. 219) that the scab always takes its origin in a lenticel, although lenticels often appear in the young scabs, and the lenticels would be the portion of the periderms through which the invasion of foreign organisms into the deeper tissues would seem to be easiest. If a lenticel is always the center of infection its tissue must change rapidly, as it cannot be recognized in many very young scabs. It should also not be overlooked that on practically every tuber there are patches of brown apparently dead cells in the periderm on which the fungus grows (as discussed in detail later) but we have no evidence that actual penetration of the outer layers is necessary.

Sections show the relation of the parts much more clearly (figs. 2 to 5). The cork layer seems to be split at this time by a varying number of hypertrophied cells into two strata, the innermost of which is usually the thicker. The thin-walled cells of both layers are rich in protoplasm and contain large nuclei. The walls of these cells, as shown by their staining reaction, are apparently pure cellulose. Those cells showing hypertrophy to any extent have at least some walls that are suberised and thickened, while those that have greatly hypertrophied have walls many times thicker than those of the strata of cork. This thickening and suberisation frequently does not affect all the six walls, and one or more are left thin and composed of cellulose. This increase in thickness apparently has no relation to the position of the nucleus in the cell. The amount of protoplasm in hypertrophying cells diminishes and in the larger ones with



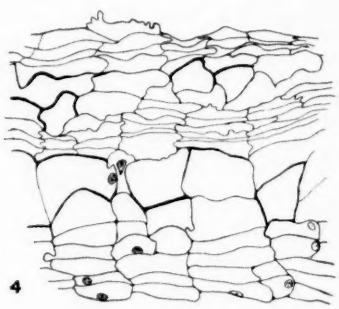


FIG. 3. Section of a young scab near its margin, normal tissue to the right. × 150.
FIG. 4. Section of a young scab showing stratification in the periderm, due to the alternation of hypertrophied and normal cork cells. × 150.

thick walls has entirely disappeared. The nuclei, as compared to those of the cork cambium, do not seem to hypertrophy, the size of the nucleus being dependent, not on the size of the cell itself, but on the quantity of protoplasm and on its activity in growth and division.

Figure 3 shows a section through the margin of one of the very young scab spots; to the right is normal tissue, to the left are the hypertrophied cells. The very characteristic manner in which the suberised walls break in sectioning is also shown by this drawing. The walls seem to splinter into fragments, like glass, under the stroke of the knife. Part of the breaks, especially in old lesions, may be due to tensions on the cell walls, but in the younger scabs they are the results of the razor shattering the brittle walls. All the drawings, except figure 3, are diagrammatic in that these broken walls are shown as they would naturally appear in the tuber.

In many instances the hypertrophy, instead of affecting only one layer, involves two or more, as in figure 4. The cork cambium in this section is split into three strata; an outer and a middle one in which the cells do not continue to increase in numbers to any extent, and an inner one in which cell divisions are apparently still numerous. Frank in his Kampfbuch (5) has a figure of a scab section in which there are four of these layers of cork cambium. The downward growth of the scab tissue would seem to be due to the repeated regeneration of the cork cambium. The stimulation of the fungus growing on the surface of the scab spot causes the cells of the cambium to hypertrophy. Almost immediately a new cambium is regenerated from the outermost of the unaffected starch parenchyma cells. The hypertrophy of the cork cambium layer seems to produce the same results as was obtained by Massart (9) by the application of pressure. The stimulus in the present case may be the same, or more probably is the result of the absorption of toxic substances produced in the growth of the parasitic fungus on the exterior.

Continued regeneration, in the method described, carries the scab tissue deeper and deeper into the tuber, as during this time the potato is continuing to grow where it is unaffected. In general, therefore, it would be expected that the very deep lesions resulted from an infection when the tuber was young. Deep scabs might, however, be produced on fairly large tubers if the conditions for the growth of the organism producing the stimulus continued always favorable. In connection with this point, the number of times the regeneration occurs is of interest. The parasitic organism on the lesion undoubtedly grows best in wet weather, possibly remaining practically quiescent when the soil is dry. There is a strong possibility, therefore, that the number of hypertrophies corresponds to the number of periods of renewed activities of the fungus, due to periods of wet weather with the resulting damp soil.

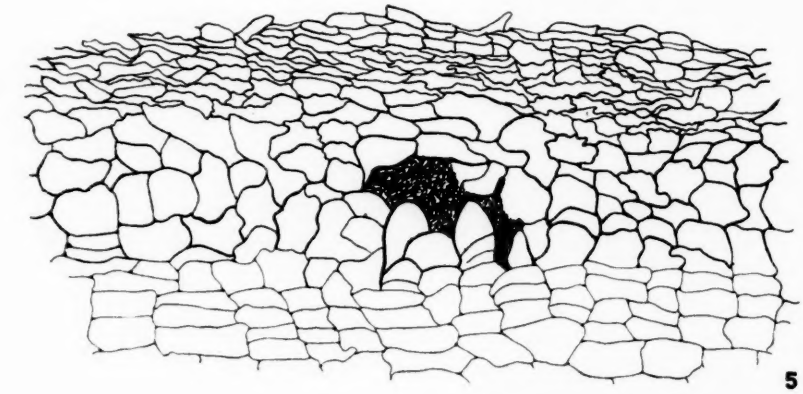
Frank and Krüger (6) claim that in Buckelschorf the outer layers of starch parenchyma are stimulated to hypertrophy, but I have never observed in any of the ordinary forms of scab an abnormal growth of parenchymatous cells, except in the manner described.

In some cases there are produced scabs of a diameter of a half a centimeter (fig. 5), but with only one regeneration of the phellogen. The cells of the outer portion of the cork cambium seem to increase in numbers while they become flattened and develop thick suberised walls. This outer strata, with the thick-walled, nearly empty hypertrophied layer placed between it and the food being stored in the potato, cannot be highly nourished and growth in it cannot continue indefinitely.

In the section of a very old scab, such as is shown semi-diagrammatically in figure 6, the diseased tissue has continued to thicken until a layer of

a half centimeter sometimes results. At the edges of such a lesion can usually be seen the turned up edges of the old outer cork layer, and lying on top are still some of its remains. A cork cambium extends under this diseased tissue, cutting it off from the starch parenchyma beneath. In the scab tissue itself can often be traced the remains of the regenerated cambium with the intervening layers of hypertrophied cells.

No nuclear divisions were observed in any of the sections examined. Growth in the abnormal tissue is necessarily slow and many divisions are



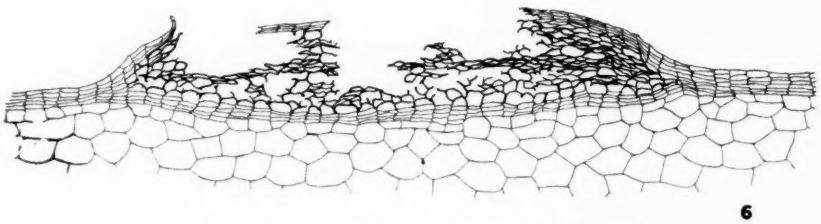


FIG. 5. Section from an older scab. × 20.

FIG. 6. Semi-diagrammatic drawing of section of an old scab.

not to be expected. The nuclei are normal in appearance in the young hypertrophied cells, although they disappear in the older ones. I am able to confirm Bolley's (2) statement that the starch grains in the parenchyma underlying the scab spots are unaffected. Instead of the starch being deposited in the form of grains and then redissolved to make cell walls, the carbohydrate material seems to be used directly, without the formation of starch grains.

THE ORGANISM IN THE TISSUES

Bolley (2) figures in the cork cambium and the underlying cells of the starch parenchyma bodies which he believed were the causal organisms. These were spheres of a diameter of 0.007 to 0.008 mm. In his later work (3), when he had come to consider the Thaxter organism as the cause of the disease in North Dakota, he published a drawing of a cork cell with this fungus in it. It appears as a "filamentous ramification of the parasite in the cells and aggregate masses of septated portions of the same in the corners of the cells."

Thaxter (11) does not mention having seen the organism in the tissues although it was externally present as a gray, mould-like deposit along the edges of the younger spots.

So far as I have been able to observe no fungi nor bacteria were present in any section examined. My inability to locate any traces of the causal organism is not to be interpreted as meaning that it is not in the diseased tissues. The apparent absence in sections of such parasitic invasions may be due to the comparatively small growth of the stimulating mycelium, to its growth only under certain conditions and its disappearance at other times, to the difficulty of distinguishing the very fine thread-like mycelium in thin sections, or to the lack of staining properties of the threads.

While it is so difficult to distinguish mycelium in sections, it can be seen sometimes in a surface view of the periderm. In unstained glycerine mounts of the corky layer of young scabby potatoes from damp, rich garden soil there may often be seen (fig. 7) patches of cells whose walls are browned. An examination of these always reveals the fact that the walls are crossed by numerous fine branching lines of about the same thickness as the walls themselves, and often difficult to distinguish from them. No such lines appear in the clear, unstained cells. These lines correspond in size and appearance to the hyphae of the organism found by Thaxter (11) to produce scab. The organism imbedded in this tissue, if not the same as Thaxter's, certainly belongs in the same group and is associated, as was his, with the development of scab. The distribution of these hyphae is very irregular, occurring on any part of the potato, but always in the outer layer of the periderm. The browning of the walls of the host cells seems to be due to the growth of the fungus, as under the narrow hyphae a broader stain of brown often shows.

Beijerinck (1) found that he could isolate from the roots of various ferns, shrubs and trees an organism (*Streptothrix chromogena*) which seems, according to his description, to agree fairly well with the one so abundant in the outer layers of the potato periderm. These organisms were im-

bedded in the tissue of the roots, as Beijerinck was able to show that they could be found in nearly pure cultures if the roots were first thoroughly washed before being macerated and plated out. They occur, however, also in the soil surrounding the roots, but in fewer numbers. In cultures, the organism browned the media. On account of the organism's almost universal occurrence, he states that it is always a saprophyte, never a parasite.

The organism found in the cork of the potato is undoubtedly the same as that described by Beijerinck, but as all stages of browning, and also the young scabs, contain it, it would seem to be pathogenic on the potato under certain conditions.

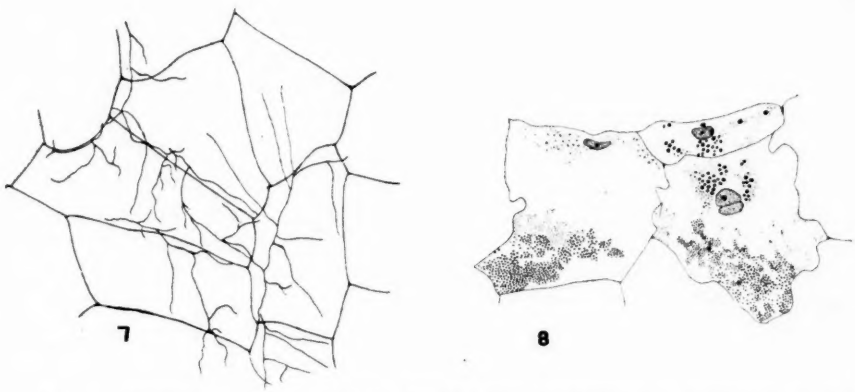


FIG. 7. Surface view of cork cells showing the distribution of mycelium in the cells. × 160.

FIG. 8. Section of phellogen; cells show fat globules of various diameters. × 180.

Although neither fungi nor bacteria were visible in sections of the diseased tissue, there are often to be observed in the cells of the cork cambium and in those of the parenchyma immediately under it, great numbers of small bodies which stain red with safranin in the safranin-gentian violet combination. The presence of these bodies in the cells is not invariable, but they are more frequent under old scabs. There can be no question but that these are the same bodies observed by Bolley (2) and considered by him to be the organisms which produce the stimulus resulting in scab. Their position is the same as those found by him and their general appearance, to judge from his figures, is similar. His observation that they were in motion in sections cut from living tissue may be true, but the motion was probably Brownian and not a vital one. As shown in figures 7, 8 and 9, there are great numbers of these globules, and they vary in size from fairly large droplets to ones so small that it is

difficult to see them with the oil immersion lens. It is also to be particularly noted that all the intermediate sizes are to be found.

The chemical nature can be made clear at once by an examination of unbleached sections from material fixed in Flemming's solution. All sizes retain the dark brown color characteristic of fat globules stained with osmic acid.

The starch seems to be lacking in the parenchyma tissue immediately under scabs. No evidence of corrosion of the grains was to be seen and the inference is that they were never formed, the fat droplets just described serving as a substitute form of carbohydrate storage. This transformation into fat is probably only a transitional stage to its deposition in the walls of the hypertrophied cells. Suberisation, according to the

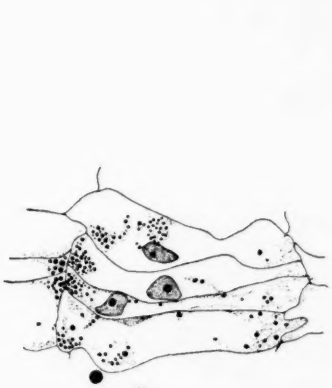


FIG. 9. Same as figure 8, but section of the outer layers of the starch parenchyma. × 225.

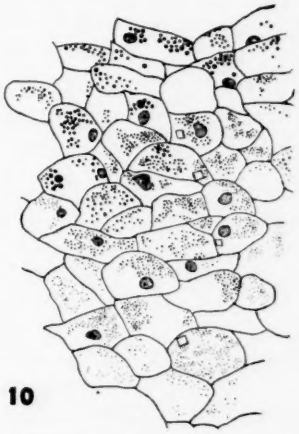


FIG. 10. Section of starch parenchyma showing the size and distribution of the fat globules. × 200.

accepted view (Van Wisselingh, 13) is an impregnation of the cell wall with glycerine esters, or substances related to them. The fatty substances deposited in the cells as globules are immediately available for deposition in the cell walls, although they may first undergo some chemical changes.

The presence of fat, instead of starch, in pathological plant tissue must be of frequent occurrence, although I find no reference to it in the literature. Küster (8) mentions the frequent accumulation of abnormal amounts of starch in diseased cells but cites no instances where fat droplets occur. In the present case, these globules serve an immediate purpose and may be considered as one reaction of the tuber in its efforts to exclude the parasite attacking it.

SUMMARY

1. The scabs may originate at any place on the potato, but frequently occur at lenticels.

2. The scab is due to the hypertrophy of the cells of the cork cambium. This condition is always accompanied in deep scabs by a hyperplasie of that layer, due to its continued regeneration from the outer cells of the starch parenchyma. The walls of the hypertrophied cells are much thickened, due to their suberisation.

3. In surface view of brown spots on the skin of scabby potatoes and in very young scabs, there can be seen in glycerine mounts, the thread-like filaments of the fungus which apparently produces the disease.

4. There occur in the cork cambium and in the outer layers of the starch parenchyma, instead of starch grains, great numbers of fat globules of varying size. These bodies are one of the results of the disease. The carbohydrate material is stored in the tissues affected by it in this form.

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IS APPLE SCAB ON YOUNG SHOOTS A SOURCE OF SPRING INFECTION?

W. J. Morse and W. H. Darrow

It is generally conceded by phytopathologists that the apple scab fungus, *Venturia pomi* (Fr.) Wint., in addition to occurring on the leaves and fruit, is at times parasitic upon young branches and water shoots and in this relation, particularly in the case of susceptible varieties, may be the source of considerable injury. There does not appear to be such a unanimity of opinion among European and American writers as to the part which this phase of the disease plays in the inception of the attack the following spring.

Sorauer[1] in discussing the manner in which the fungus passes the winter mentions first the infected branches and then the perithecial stage upon fallen leaves, and even goes so far as to state that the fungus may live over on the sound growth and become a source of infection the following spring. Massee,[2] in a recent text-book, while he describes the ascigerous form of the fungus, does not mention it in any way whatever as the source of spring infection. His position with regard to the importance of the diseased shoots is shown by the following quotations.

"In early spring infected shoots are readily recognized by the much injured bark or skin which is frequently torn into shreds, more especially near the base of last year's shoot. At this period of the year the exposed blackish patches are densely covered with the Fusicladium form of the fruit which is carried by wind, rain, etc., on to the young leaves, which become infected. . . . From the above account it will be seen that the young apples are mostly infected by spores produced on the leaves. But the leaves could not become infected except by spores produced on diseased shoots, consequently diseased shoots are the source of all the mischief. . . . . ."

In another recent article Voges[3] has also claimed that the apple scab fungus lives over winter on the twigs and is thus a source of infection of the young leaves and fruit in the spring. On the other hand, Aderhold[4]

[1] Sorauer, Paul. Handbuch der Pflanzenkrankheiten. **2**: 249. 1908.

[2] Massee, George. Diseases of cultivated plants and trees, p. 206. 1910.

[3] Voges, Ernst. Die Bekämpfung des Fusicladium. Zeit. für Pflanzenkr. **20**: 384–393. 1910.

[4] Aderhold, Rud. Die Fusicladien unserer Obstbäume, II. Landw. Jahrb. **29**: 541–587. 1900.

in 1900, after many years of observation, while noting the frequent occurrence of pear scab on young twigs, particularly in nurseries, and emphasizing this as an important factor in carrying the disease of pears over winter, states that only two cases have come to his attention where apple limbs were so attacked. This leads one to infer that he considers this form of the disease on apple as of no importance as a source of spring infection.

So far as the writers of the present paper have been able to learn, little evidence has been obtained in this country in support of the position that diseased twigs are important factors in carrying the apple scab fungus over winter. According to Clinton[5] the spores of the Fusicladium stage probably do not retain their vitality for any considerable period of time. In one instance he found the fungus occurring on the young growth of a badly infested crab apple tree. The following spring a thorough examination of the twigs failed to show any sign of the fungus on them. During three years of observation in Illinois he did not find any evidence that the diseased twigs were a source of infection the following year in that state.

A few years later Lawrence in Washington made a somewhat similar series of observations and experiments and came to the conclusion that the fungus was not carried over winter by the summer spores.[6] In this connection it may be mentioned, however, that the ability of the fungus to live over winter on the diseased branches does not necessarily depend upon the viability of the spores produced the season before. Some have suggested the possibility of the mycelium remaining alive in the attacked twigs during the winter and being in a condition suitable for very early production of conidia the following spring.

Conditions during the growing season in Maine were probably more favorable for the development of the apple scab fungus in 1912 than for several years previous. Consequently a large amount of damage was recorded on both fruit and leaves throughout the state. Early in the following winter specimens of young apple branches attacked by scab began to come to this station from correspondents in various parts of the state.

The trouble seemed to be so general and widespread and the opportunity to secure data on the point mentioned above seemed so favorable that arrangements were at once made to secure specimens of apple twigs so attacked from as many and as widely separated sections of the state as possible. In this connection the writers wish to acknowledge their indebtedness to State Horticulturist, A. K. Gardner, and Assistant State

[5] Clinton, G. P. Apple scab. Ill. Agr. Exp. Sta. Bull. 69. 1902.

[6] Lawrence, W. H. Apple scab in western Washington. Wash. Agr. Exp. Sta. Bull. 64. 1904.

Horticulturist, H. P. Sweetser of Augusta, as well as to Mr. George A. Yeaton and Mr. Arthur L. Deering, County Directors of farm demonstration work for the University of Maine College of Agriculture in Oxford and Kennebec counties, for valuable assistance in securing many of the specimens studied. These specimens were obtained from Androscoggin, Kennebec, Oxford, Penobscot, and Waldow counties, representing a considerable portion of the apple growing section of the state.

The affected branches showed very few of the characteristics described by Massee. While the bark was frequently affected near the tip, in many cases the diseased area began one or two or even three inches back on last year's growth and extended back from one to several inches. There was no tearing of the bark into shreds, but it was more or less thickly studded with light brown spots. Scattered spots were, as a rule, oval to elongate in shape, although frequently nearly circular, and were usually not more than a millimeter in diameter. Quite often, however, in severe cases these spots ran together, forming a diseased patch of considerable area which appeared as a scurfy coating on the young bark.

Closer examination of the light brown spots showed that they were blister-like pustules resulting from the death and pushing out of the epidermis. In the center of each pustule was a blackish portion composed of the olive-colored conidia of the fungus.

A detailed study of the conditions in the field were made by the junior writer in the vicinity of Orono. This was of necessity somewhat limited, as the location is outside of the best apple growing district of the state. It was observed that strong-growing water sprouts were more badly affected than young growth on the ends of branches. Water sprouts two or three feet long were often diseased for the last foot or more of their growth. Also the more vigorous growing twigs at the ends of the branches were the more severely attacked. Those which showed but little elongation were only slightly infested, or not at all.

In an orchard containing seven varieties, McIntosh and Fameuse were the worst attacked. Milden and Westfield ranked next in order of susceptibility. Only an occasional twig was found to be affected on the Northern Spy trees and these but slightly, while the Oldenburg and Tolman trees were entirely free from injury.

In the majority of cases the pustules on the affected twigs contained numerous Fusicladium conidia. Many of these spores were found to germinate readily in prune decoction and in prune agar. These germinations were made at various times during the latter part of the winter and early spring up to about the first of May, or till about the time the leaf buds began to open. Pure cultures were made by means of prune agar, and the fungus was grown upon a variety of culture media in comparison

with an authentic culture of *Venturia pomi* isolated from apple fruit. These agreed in every respect.

Young apple trees growing in the greenhouse were then inoculated by spraying the foliage with spores produced in cultures of the fungus from apple limbs. They were covered for a short time by large, glass bell-jars to secure a moist atmosphere and at the end of a month or 6 weeks the leaves of the trees so inoculated were badly attacked by apple scab. Scab did not develop on other young trees in the greenhouse which were not inoculated.

Voges, as mentioned above, places much emphasis upon the diseased twigs being an important means of the overwintering of the fungus and maintains that the mycelium itself exists on the diseased branches as a living stroma which begins to vegetate early in the spring and to produce conidia, often as early as March. Our studies do not throw any light upon this phase of the matter. It is true that in several instances diseased branches were received where no spores were found within the pustules. These, however, were collected and sent in by correspondents at some distance from the laboratory making it impossible to carry on further studies upon the trees from which the specimens came. A large part of the spore germinations and local collections were made after the first of March. While it is possible that some of the later germination tests in April were made with spores recently produced, it does not seem probable under the climatic conditions which prevail in this state, that the fungus would be sufficiently active to fructify early in March.

From the above it would seem evident that in this climate it is perfectly possible for the apple scab fungus, and the conidia of the same, to live over winter on diseased twigs and water sprouts, and that this form of the disease may be an important factor in the production of early spring infection where susceptible varieties of trees are grown. In this connection it is a matter of extreme practical importance to know how effective a dormant spray of bordeaux mixture or lime-sulphur is in controlling this phase of the disease. In the laboratory it was found that simply dipping the affected twigs for a few seconds in the winter strength lime-sulphur sufficed to kill all living spores, but no results of a regularly conducted spraying experiment were secured. However certain observations made by the senior writer furnish some rather interesting data upon this subject.

These observations were made upon a block of four-year-old McIntosh trees in an orchard in the western part of the state. This consisted of 40 trees, five rows of eight trees to the row, set on an acre of land. They had been well fertilized and cultivated, were seven to eight feet tall and were healthy and vigorous with the exception that several limbs on prac-

tically every tree had been attacked by scab the season before. Some of these were so severely injured as to kill them back for several inches. However, the badly attacked trees were by no means confined to any one part of the block. They were visited about the first of July.

It was the original plan of the owner to spray the trees before the buds opened with a dormant spray of lime-sulphur and again with the same material diluted to summer strength, just before the flower buds opened, and a third time after the petals fell. The first application was made about the first of May, using a 33° Baumé, concentrate, diluted 1 part to 10 of water. At this time the leaf buds on one row of 8 trees were slightly in advance of the rest and were just beginning to open. The owner fearing he would injure them omitted the application of the strong spray upon this row of trees. However the remainder of the entire block received the dormant spray at this time, and all received the two later applications.

At the time the orchard was inspected, the leaves on the 32 trees to which all three applications of the spray were made were exceedingly healthy, although scab was not entirely controlled upon them. Those upon the 8 trees where the dormant spray was omitted showed a strikingly different condition. Fully 75 per cent were attacked by scab and a large proportion of these were quite severely affected. In fact only those of recent growth were free from the disease.

In closing it may be said that it is not our contention that the ascospores formed on the leaves of the previous year are not the source of a great proportion of, and usually all, of the early spring infection of apple scab. It is, however, maintained that, under certain conditions, and with certain varieties of apple trees, diseased twigs and water sprouts are an important factor in the propagation and spread of the disease at the beginning of the following year. Also it would seem from the observations here recorded that where limb infection exists the application of some strong fungicide immediately before the leaf buds open will greatly reduce the amount of spring infection from this source.

MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

PHYTOPATHOLOGICAL NOTES

Puccinia pruni-spinosa killing plum nursery stock. In the course of some nursery inspection near Fort Smith, Arkansas, the "plum rust" (*Puccinia pruni-spinosa*) was found killing nursery stock. The plum affected was reported to be Abundance. Several trees in the nursery row are badly affected, and a few of the trees had died on August 5.

J. LEE HEWITT

Rose Mildew. I very recently found a very interesting case of rose mildew on the low wild rose, *Rosa arkansana*. This species is apparently immune to the disease, at least here, but on some of the leaves there has been formed a gall, probably caused by gall flies, and these galls were badly infested with the oidium of rose mildew. The galls, about one-quarter to three-eighths of an inch in diameter, were completely covered with the white mass of the oidium, but it did not extend to the surface of the leaves in any degree.

I also found some very excellent specimens of the peach scab, *Cladosporium carpophilum,* on the leaves of some seedling peaches. The spots were small, circular, about 1 to 3 mm. in diameter, dark green to brown. The color is even, the margin entire. At first sight the spots look like small numerous apple scab infections. The spots are mostly on the upper surface perhaps, but are on both surfaces on the leaf.

J. LEE HEWITT

Personals. Dr. James T. Barrett, recently Associate in Botany at the University of Illinois, and Chief Assistant in Botany in the Illinois Experiment Station, has been appointed Plant Pathologist in the Citrus Experiment Station and Professor of Plant Pathology in the Graduate School of Tropical Agriculture at Riverside, California.

Personals. John Stevenson, recently a graduate student and assistant in the Department of Botany at the University of Minnesota, has been appointed assistant plant pathologist in the Sugar Planters' Experiment Station, Rio Piedras, Porto Rico.

Mark A. Carleton has recently resumed his duties as cerealist in the Bureau of Plant Industry, after a year and three months' leave of absence as director for the Pennsylvania Chestnut Tree Blight Commission.

Orlo A. Pratt, formerly assistant plant pathologist in the Idaho Agricultural College and Experiment Station, has been appointed scientific assistant in the office of cotton and truck disease, and sugar plant investigations of the Bureau of Plant Industry. His headquarters and address is Jerome, Idaho.

H. A. Edson of the Bureau of Plant Industry has transferred his headquarters and address from Madison, Wisconsin, to Washington, D. C.

Lewis E. Longely, recently floriculturist at the Washington State Experiment Station, has been appointed scientific assistant in the office of cotton and truck disease, and sugar plant investigations of the Bureau of Plant Industry, with headquarters at Madison, Wisconsin, where he will be engaged in breeding experiments with sugar beets.

C. W. Carpenter, sometime assistant bacteriologist in the Vermont Experiment Station, has been appointed scientific assistant in the office of cotton and truck disease and sugar plant investigations of the Bureau of Plant Industry. C. M. Woodworth, scientific assistant in the same office, has resigned in order to undertake graduate work at the University of Wisconsin.

NOTICE TO ALL MEMBERS OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The annual meeting of the Society will be held in connection with that of the American Association for the Advancement of Science, at Atlanta, Georgia, during Convocation week, December 29, 1913 to January 2, 1914, the exact dates to be subject to later arrangement.

In accordance with a resolution adopted by the Society at its Cleveland meeting, the Secretary was instructed to call for titles and abstracts of about 200 words, of all papers to be presented at the coming Atlanta meeting. Abstracts should be in the Secretary's hands by Nov. 15 in order that they may be published and distributed to members before the meeting.

C. L. SHEAR,
Secretary

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